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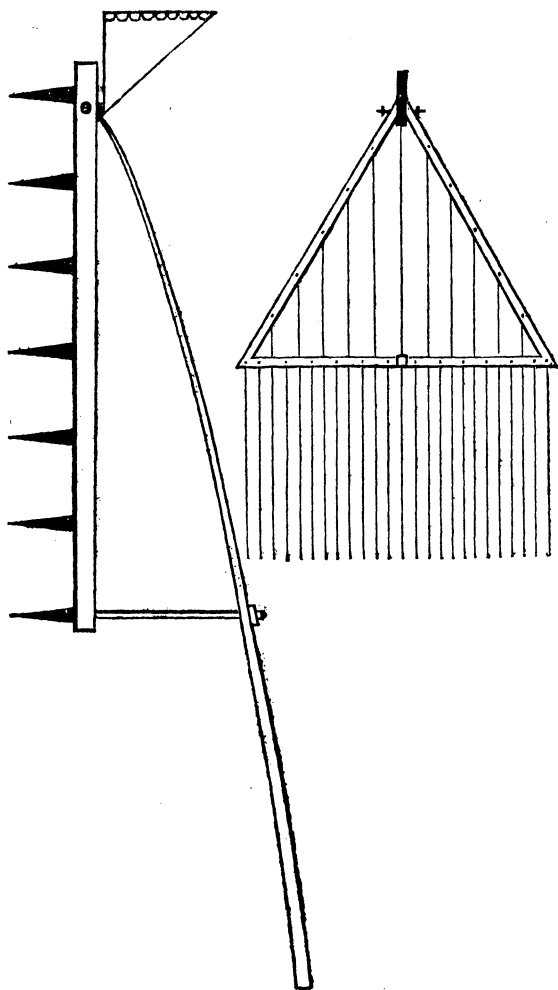
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A line of the 1st of June 1864
from the 1st of June 1864
to the 1st of June 1864



A profile and kite View of a Harrow presented by the Author
to Sir JOHN SINCLAIR, President of the Board
of Agriculture.

Presented to

W. A. Gompertz

by

the Author

20 August, 1844

A

TREATISE

ON

WHEEL CARRIAGES.

A
TREATISE
ON
WHEEL CARRIAGES;
OR,
CONSIDERATIONS, COMMENTS,
AND
CERTAIN CONCLUSIONS,
RESPECTING THEIR
PRINCIPLES AND CONSTRUCTION.

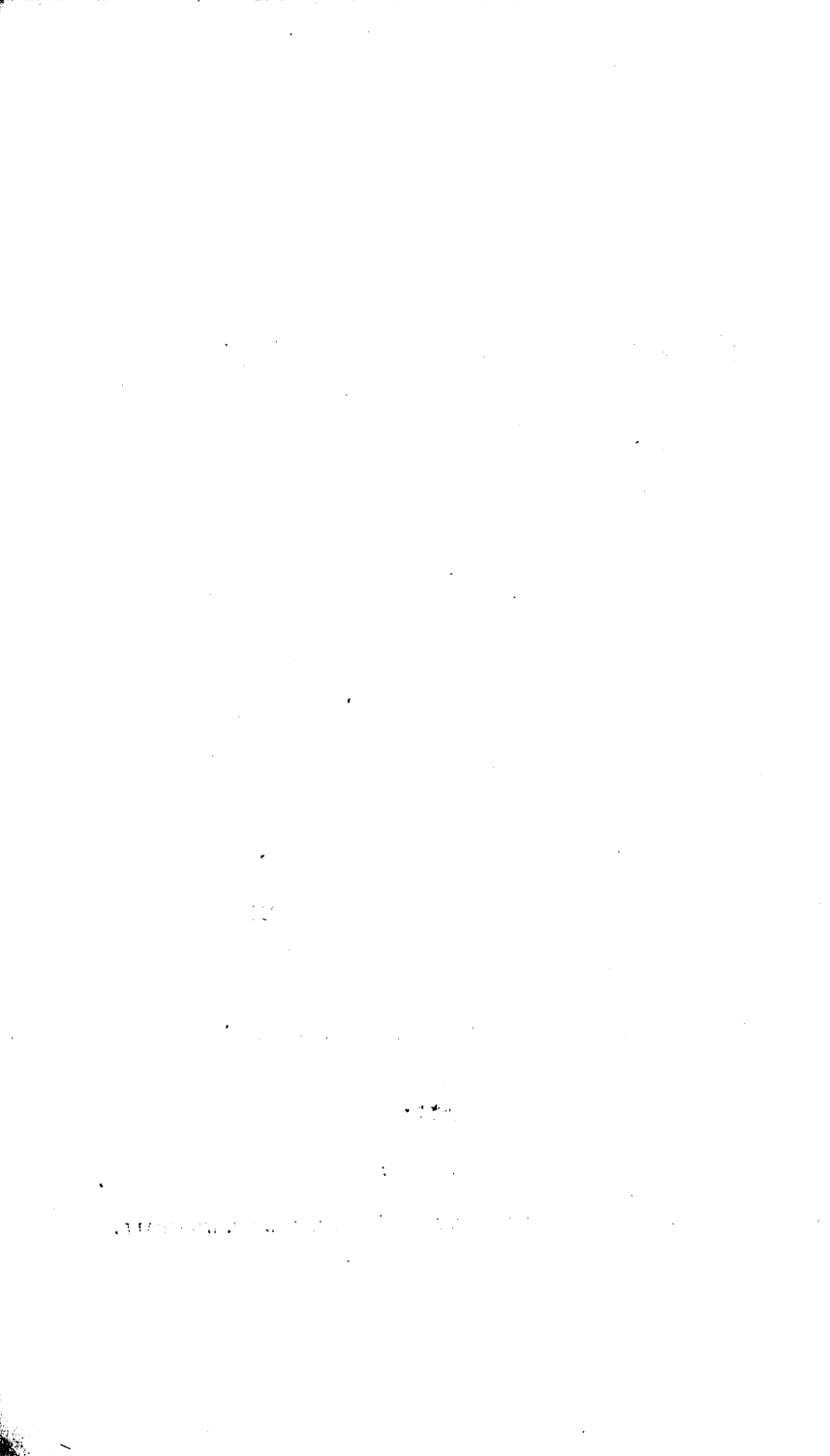
BY
DAVID MEADE RANDOLPH.

" QUOD NUNC RATIO EST, APPETUS FUIT."

LONDON:

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1810.



mundie
11-17-29

P R E F A C E.

THE native energy of an ardent soul is sometimes happily tempered by the twin attributes discretion and doubt. Yet when these sanction the effusions of a mind seeking the attainment of practical advantages, it would be fastidious in the extreme to restrain an enterprize glowing with honest speculations. Availing myself of a liberal admission into the Office of a distinguished Institution, whose deliberations are so ably guided by so honorable a character as Sir JOHN SINCLAIR—seeing, among the variety of Rural Subjects and Implements of Husbandry there inviting inspection, nothing so simple, and at the same time so *practically* useful, I could not resist the temptation of humbly adding the model of a *Harrow*, the invention of youth, and the support of a *Farmer* through many years! And, since in this simple, but important instance, the powers of the *Lever* and the *Wedge* are so fully exemplified, why may they not subserve the *more important* purposes

of *reciprocating* the superabundant products of Art and Industry? *Improving* upon the true nature of construction on present *principles*, so little studied, and still less demonstrated, in “Wheel Carriages?”

These considerations, and the magnitude of the subject, as taught by certain “Reports of the House of Commons” since May 1808, it is most respectfully hoped will secure to an obscure Individual, the favour of a generous Nation! And, that these preliminary remarks will protect him from too severe a Sentence, if indeed his Labours shall have been in vain! For, he trusts that the simple proof of error, or even folly, will cease to be severely censured, on the recollection that it is a *feeble attempt* of an Individual, by his well meant exertions, to accommodate the *many*.

THE AUTHOR.

A

TREATISE

ON

WHEEL CARRIAGES.

FLATTERED by success in an inferior enterprize, I have been induced to proceed still farther, and offer some desultory observations upon the subject of "Wheel Carriages"—collaterally, and briefly, noticing the properties of the *horse*, whose energies are applied for putting them in motion, and the united effects of both upon the road over which such vehicles usually pass.

In point of order, I would wish with great diffidence to excite attention first to the *horse*, as the momentum necessary for the purposes of draught. His standard height I would fix at $14\frac{1}{2}$ hands, subject, as all general rules must be, to several exceptions. Fixing his centre, at four feet, it will be useful to enquire into the nature of his properties, so far as they are applicable to the question under examination. Doubtless the horse must be considered a machine equally with the carriage, when

B

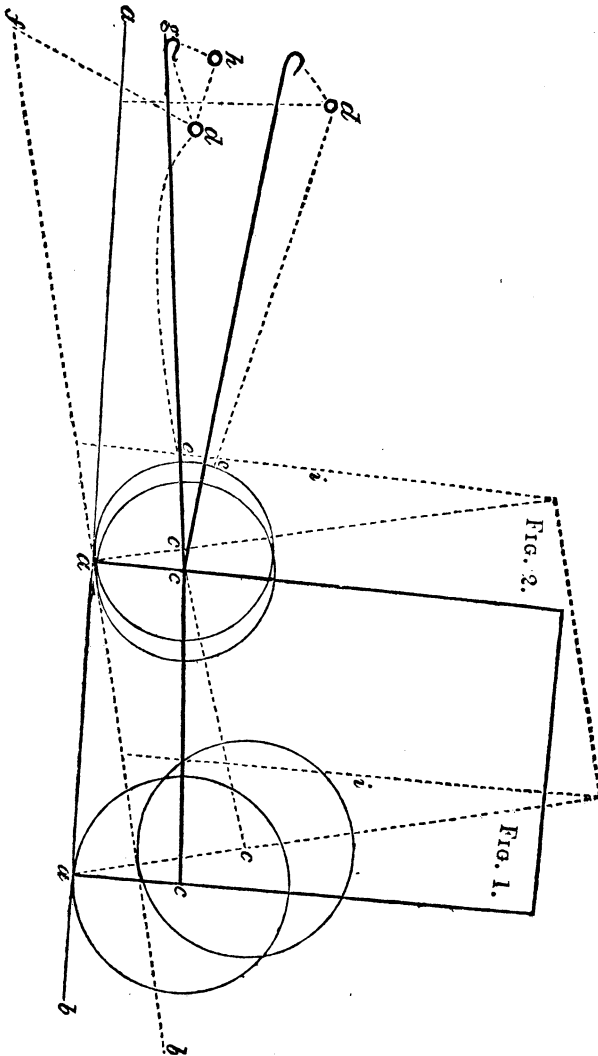
we are calculating respecting his powers; and in order to adjust the one, it is evidently necessary to comprehend the other. If to the principle of *his levers* we apply the practical eye of intelligence, we shall readily deduce that the preference should be given to the blood-horse—viewing him as superior in point of symmetry, formed of finer materials, his *levers* more accurately poised, and his fulcra more acute; by which means his motion is consequently quickened, and its concomitant re-action proportionably diminished. Nevertheless horses of an intermediate quality between the blood and cart kind may ultimately be preferred, from other considerations. And, hence, an important subject is furnished for the contemplation of the breeder, who, in some degree, may regulate, in the animals intentionally bred for draught, the *quantity* of necessary motion. All machinery being more perfect, proportionably as it is constructed upon a more accurate scale; its “weight” increased and its quantity diminished consequently affects, in equal ratio, the *momentum* of all bodies. The doctrine of the “musket bullet,” it is believed will not controvert these simple ideas; whilst the *mule* by his *kick* manifests his superiour quantity of *motion* to that of the dray or cart horse.

Contemplating the centre of gravity, who can doubt the impropriety of elevating the load of the heavy coach? (see figures No. 1, 2, 3.) Its centre is never at rest, for not only is it continually dis-

FIG. 1. *a, a, b*, contact on a plane; *c, c*, axes of the wheels; *d*, horse's centre; *e*, swingle bars to which the traces are attached.

FIG. 2. *a, b*, an inclined plane; *c, c*, axes of wheels; *d*, horse's centre; *e*, swingle-bars, &c.; *f*, horse's fore-feet; *g*, breast chains or pole pieces; *h*, horse's *drawing* centre; *i*, line of gravity or perpendicular, exhibiting the increased pressure upon the fore wheels, and consequently requiring draught down hill to pre-

FIGURES I, II.



vent overturning, to which the body of weight is disposed, if the Carriage is suddenly stopped in its progress, the hind wheels being raised off the ground by the lever formed of the whole mass or body of weight.

turbed by the necessary propulsion, but by its towering height; its worse than useless number of springs, which occasion cross and contrary agitation; and by having its gravity placed before, instead of behind the centre; or, at best, suspended between two fulcra, and thus the effects neutralised; and, by a continual jolting motion, retarded by action and re-action. These and other considerations, more easily conceived than described, decide against the present preposterous *fashion*; exhibiting to an admiring world specimens of human invention, in *designing*

FIGURE III.

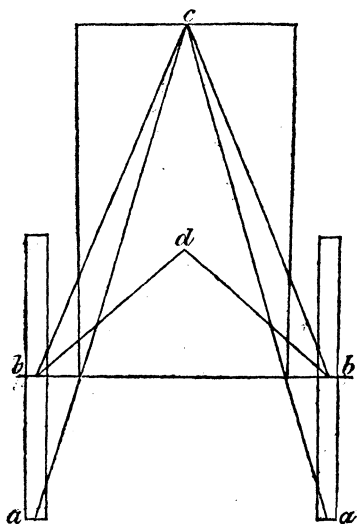


FIG. 3, or, rear view of a Coach. *a, a*, points of contact on the road, or tread of wheels; *b, b*, the axes, the common fulcrum for the lever, constituted by the action of the body; *c*, the summit of gravity over its centre, as by the high loaded Coach manifestly appears; *d*, the summit of gravity over the same centre, as is supposed to constitute the merit of the present project; *c, a, a*, the true angle of bearing and action exhibiting a constant disposition to upset *laterally*! Q. E. D.

the component parts of a machine, the errors, and imperfections of which, are better understood by the practical superintendant: like, as in modern times, disciples of the new school are continually *increased*, without affording improvement, to societies. The momentum of the blood-horse, arising from his possessing more *motion* than *power*, coincides with the position, that "half of the *power* at the acting end of the lever will balance the whole of the difficulty at the resisting termination." Hence, then, a farther proof of the rational preference that should be given to this animal. And we may add, according to the mathematical maxim, that "what we gain in power we lose in time." Or, "substitute motion for power." "The balanced lever," by the smaller, but quicker, motion overcoming the resistance.—The "Four-wheel Carriage," being the "double lever," exhibits the effects of the extended springs, as in pleasure Carriages; whereby the object sought, an *easy motion*, is *more than* obtained; for, the great length of levers from their *fulcra*, with the power of gravity applied at their ends, creates a greater degree of *reverberating* motion; and as necessarily occasions a correspondent *pressure* at the points of contact with the road, the real base of the *ostensible fulcra*, and thus retarding by a continued concert of action and re-action between the several bodies concerned, increases the resistance of the obstacles to be overcome.

Scientific men may amuse themselves in their closets with philosophical disquisitions, whilst the *inquisitive traveller*, or experienced *coachman*, with *his* ideas of *first principles*, and a sound discriminating judgment, perceives, and admires the beautiful order of nature; and, unblest with *too much knowledge*, applies her simple laws as his practical skill may from time to time occasionally suggest. Instead of "two," he divides "the resistance

into four parts," each subject to the dividing power of action and re-action, according to chance or incidental circumstances; for time and chance may happen even to *Wheels*. Who that has ever rode upon the top of a heavy Coach, so complex and *be-sprunged* as they generally are, that has not *felt* the *error*, in construction, even when so remote from the point of friction; exciting, by its short, but reiterated motion, sensations not more agreeable than when seated in a chair, placed on the floor of a common farm waggon? Or who, that has ever been at sea, has not perceived the necessity of keeping the ship in good trim, even after that machine has been constructed upon the most exact dimensions and geometric principles? And if it be true, as the fact has been ascertained, that the walking of men on deck, much less mounted aloft, *retards* the progress of the vessel; and that *dead* ponderosity retards more than animated weight when properly adjusted; the same reasoning will apply to carriages; because there is a strong similitude between the two bodies in motion, though on different elements; for where else, but *at* the centre of gravity can be conceived the effect of the masts, &c. &c.? At the same time due allowance must be made for the *manner* of applying the several *agents*—the one an impellent, and the other a tractive power.

If the acting part of the lever be the shortest, might it not be proper to ascertain by anatomical construction the comparative proportions of the two animals employed in particular cases, so intimately connected with the present subject? more especially, since it has been *proved* that the *one* is furnished with his vital organ, the *heart*, upon a much larger scale, with a proportionate quantity of blood? And, from an experiment, by which these two properties have been discovered, it would seem that his bones, muscles, and minutest fibres, the

whole materials of which he is formed, are more subtle and dense. His *vis motiva*, or that which tends to *motion*, is manifestly superior; whilst that of the other has a greater *vis inertia* and tendency to rest. The last may indeed, upon the deceptive principle of dead *weight* or matter suspended on a "pulley," put the Carriage *into* motion by his "fall" and "his undulatory power;" but, when once *started*, the tendency of the former to perpetual motion may be conceived, if not clearly demonstrated. Hence, too, the evident necessity for preserving the trim of the Coach, for promoting a regular and steady *propulsion*, the chief desideratum.

I would also particularly observe, that in descending hills, when the occasion is urgent, the back-chain appears to be the only safety; but the occasion cannot indeed be frequent in a country boasting so honorably of its superior roads. In all cases, so far as I have been able to observe, a carriage, upon the principles I am attempting to support, will require no other power to regulate * its *descent*, than able horses and a skilful driver: for, in this case it will not as at present be necessary to *run* down the hills, in order, that, by a *continued* and *doubtful remedy*, the *draught* may prevent the vehicle from overturning; which practice I have witnessed, not without some degree of terror.

To determine the truth of the principles adopted in this new system, let us endeavour to demonstrate the errors of those we combat; thus, let us try Mr. Walker's combination of the *lift* and *draft*. This figure represents the profile of a high and heavily

* *This operation*, it is hoped, will be provided for shortly by a gentleman *summoning* the author to allow *his caveat*, for an apparatus or machine whereby to *stop* carriages! - And, since these labours are designed for the *opposite purpose*, an interview was declined.

loaded coach : A, B, is the perch connecting two axles by a depressed line of *incident* of three degrees ; B, C, the line of *reflection*, or lift and draft (supposed) now in use ; E, D, F, the *parallel* or *true* line of *draft* ; D, the centre of the wheel horses, *lifting* from B, and drawing from A ; E, the leading horses' centre, *lifting* and *drawing* from the same points as before ; the point A, being the true point of common *resistance*. Now, mark the *lift* from B to G ! the *concerted lift* from B to H ; and, the difference between G and H will exhibit the ratio of *draft*, compared with B, H, the draft of the leaders ; whilst D, I, manifests the superior quantum of *lift* at D to that at E ; the line of *traction* E, A, *adding* to, or increasing the *lift* of D, B, by a *discordant* effect at K. Let us now examine the *gravity* ; or, how the load is to be considered, as *affecting* our principles ! The figure B, L, M, A, represents the Coach in its common state on a plane ; when, according to received opinion the weight is truly *thrown as much as possible before* ! Does not this figure, at the first glance, prove how much more the smaller wheel has to sustain, than the larger ? And, consequently, accounts for its "wearing faster" by a more powerful *cause*, than that of *superior velocity* ? And, moreover, if the mind can conceive the *completely lifting* and *falling* of the front wheels from the *plane* to the line D, G, A, will not the *hammering* effect appear to contribute still more to its destruction ? And, if, *in fact*, this never were the case, it argues nothing against *a tendency* to that end ; or, of such an effect to an inconceivable perhaps, but undeniable degree and extent. The figure G, N, O, A, surely must prove the *distress* of the *team* in their unre-mitted efforts to *make* the original figure B, L, M, A, assume this appearance ! These observations are predicated upon the lines drawn from the com-




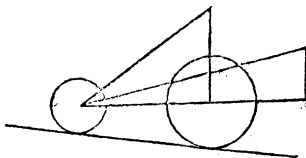
mon point B,—how much more aptly do they apply, if from the splinter-bar and pole *upon* the line B, C,!! Again, if the Coach be passing on a plane, the lines M, R, and L, S, being perpendicular to the plane T, U, prove the absurdity of *lifting* in order to produce a *progressive* effect; whilst that of E, D, F, clearly demonstrates the true line of traction. And, still further to show the *conflicting* effect of the *lifting* power, so much more than requisite, created and constantly exerted in the *present fashion*, let us view at the same instant the figures B, L, M, A, continued to S, and R,—B, N, O, P, and A, M, Q, P; the first being the state of the carriage gliding smoothly along, whilst the other *two* enable us to conceive and detect the *conflicting*, and *incessantly erroneous effect* of the never ceasing *tendency* to produce a *partial collision upon* the plane, so incontrovertibly apparent in all the extent of its *retarding* and repulsive tendency at P: the carriage at all times being thus made to *act* and *re-act*; and, under the most favorable circumstances *neutralising* instead of *propelling* the body we are seeking to get forward with the greatest speed, œconomy, and accommodation!

In addition to FIGS. I, II, III, *opposing* the “high loaded Coach,” wherein the error in principle in some measure has been exhibited and exposed by *drawings*, it may not be amiss to apply these same principles to conceive or draw similar lines from a *rear view* of those *contending tractions*; to show an equally false and correspondently *lateral effect*, created in a greater or less ratio according as there were more or *fewer springs*: particularly by those so unhappily contrived *crosswise*, or so as to act in diametrically opposite directions: Thence it would more conclusively appear, that the carriage was continually *vibrating* between the *two lines* of support, the wheels, at one time throwing

all the weight on *one side*, and again, on the other, worrying and fatiguing eternally the poor draught animal, by the alternate and instantaneous necessity he is thus laid under to increase or diminish his exertions.


Consistently with the end in view, I would sup-

pose a block of marble, of this shape,  to be placed upon the axle-trees reaching the whole length from centre to centre,—would not less power be required to move it than if the same bulk and weight were in the form of a cube? and most certainly it would require less than an inverted cone. And, I am clearly of opinion, that the same *matter* placed in either of the following *forms* requires still



less; that which projects behind the centre, forming upon the front axis an angle equal with that of reflection, by which it is



drawn; presenting a rear view thus , as the one or the other form shall be conceived; the force of *incidental attraction* aiding *motion* by the indisputable laws of gravitation. The four wheels supporting *gravity*, whilst its *power* is diffused, acting and re-acting according to incidence and reflection, elevation and depression, in equilateral triangles (the true cone); subject also to the other laws, resisting the *pressure* of *gravity* by elasticity upon the road, where it is more manifestly diminished by a tendency to a state of *motion*.

This theory may be well illustrated by substituting upon the above *four wheels* an *inverted cone*, thus deducing truth from relative and comparative arguments. Hence it appears to result, that the space between the two wheels, or length of axle-tree, should be double the perpendicular from the centre of gravity to its base, or bearing on the same; and, by this, the length of perch should be adjusted, keeping the point of gravity in view, where it must consequently serve as the common point or *summit* of *four* several *triangles*, or *smaller cones*, combined into one general or larger body, resting flatly on the floor or platform of the carriage; subject, moreover, to a *correspondent attraction*, from the flat and under surface; diffusing, incomprehensibly, *gravity* and *motion*, in a similar manner to the reflected and refracted rays of light. *Vide* FIG. V.

To the heavy Waggons it appears these principles equally apply. And, upon the *draught* of these I would remark, that the effect of two *distinct lines* of horses must repeatedly counteract each other: the two pair of shafts *conceal*, by their firm and steady resistance, the zigzag motion of the wheels, diversifying their action upon the road: the one retarding, and the other increasing, velocity; and, this more or less, according to the increased variation in the step of the different horses in the two *lines*. It seems more consistent that they should draw from the centre: the power of the wheel-horses operating by a *tight pole*, or *breast-chains*, to this effect; whilst the fore-horses should draw from the *point of a pole*, firmly attached to the axle-tree by *futchels*; the two lines of traction thus forming a triangle, disposing every effort to *union*, whether regular and equal, or *vice versa*.

These reflections might be farther elucidated by referring to arguments; but I leave this task for others, and proceed to the effect of twenty, instead

of ten, horses to a Waggon. Only examine their undulatory and divergent motions, their action and re-action, traces vibrating between double levers, while these are acting upon a common fulcrum; and say is it difficult to prove, whether they accelerate or retard progress? The maxim, that "velocity diminishes gravity"—incidents and reflection,

FIGURE V*.

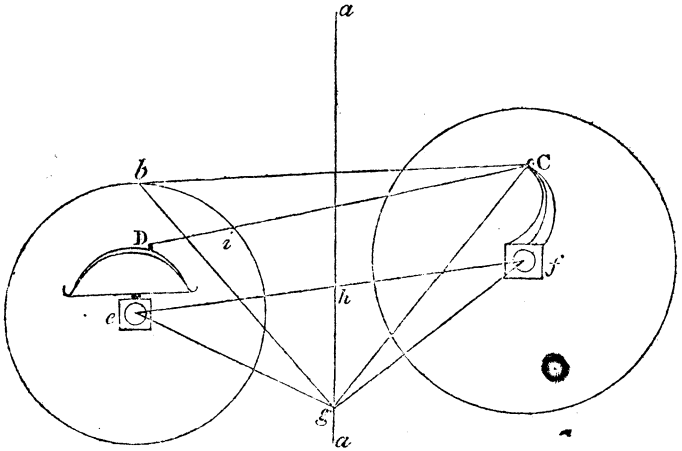


FIG. 5. *a, a*, state of gravity; *b, c*, the level pressure on springs; *d, e*, the inclined pressure on springs; *f, g*, axes.

Compare the angle *e, g, h*, with *f, g, h*, and in the same decreased ratio of one base, so will the power of attraction, when disturbed by the efforts of the horses, be disposed to *propulsion*: and still more disposed to that end by the angle *g, i, c*, in support of the principle; and according to the Newtonion doctrine, the nearer the earth the greater the power of gravity.

* This figure is designed to demonstrate the power of gravity, according to its *disturbed state*; and, its *effect* in contributing towards a *propulsive* motion: proving also the error of the front springs (or long sea springs) being placed on a level with those behind.

combined with the theory of vis inertia, argue in favor of the blood-horse, and his standard height; adjusting the fore-wheels to his *centre*, and the hind wheels to an elevated angle from the *leading fulcrum*, throwing, in all cases, the balance *behind* the centre of pressure.

To Mr. A. Walker's talents and acquirements, so honorably drawn from the schools of science, and to his ingenious philosophical experiments, is yielded the willing and well-merited tribute of profound admiration; nevertheless, consistently with those *practical conceptions and ideas*, with which I have been furnished, from a life of necessary experience, it would afford high gratification to meet him, upon the high-road, prepared for a comparative experiment, by means of a ten-horse Waggon, which should be under his direction, and equipped in the ordinary mode; this he should cause to be loaded, till *ten* of the stoutest horses could no longer draw so heavy a burthen upon a *plane*. I should propose, then, to have an equal *weight* of the smallest *draught mules*, geered also in their accustomed manner; the cost of each *team*, together with their contingent expences, should be estimated and clearly understood. I would then hitch to the same Waggon a given *quantity* of *weight* of mules, which should from time to time be *increased*, until the Waggon should be got into motion; the only additional fixture required for the experiment would be a stout rope, to be disposed of in a particular manner, adapted to the accommodation of the mules, on *very different* principles of *lift* and *draught*. Thence might be discovered, most decidedly, the difference, as to power of draught, between the "larger dray-horse, whose centre was four feet two inches," and the smaller and more humble *beast*, whose centre would be lower perhaps than half

that height, actually employed in effecting the purposes of our object and exposing the truth of an important desideratum*.—18th March, 1809.

From a proper conception of the principle of vis inertia I would substitute the *swingle-bar* and swingle-trees, for the firmly fixed *splinter-bar* and upright knobs, over which the traces are usually hitched; the latter *confining* the action of draught and lift, and consequently increasing *dead weight*, as may be perceived by the wearing of the traces at the point of contact; whilst the other mode evidently increases that *tendency to motion*, so much the object of our enquiry and wish: and this, too, in no contemptible degree, by the correspondent action and *re-action* of the breast-chain, ends of traces, swingle-trees at the end of the pole, and the general construction of the whole set of geers or harness. For upon this apparently inconsiderable point of the subject before us, much depends, for the more we increase *action* or *motion*, whatever quantity is produced *before* the centre of *gravity* effecting a descending tendency in the first instance, and by the efforts of the horses, *assisting* that power of *reflection* so necessary to progress, we at the same time facilitate the *lift* and *draught* by which obstacles are overcome. As to the preference of wheels, I would recommend with much deference those that are perfectly cylindrical; axle-trees *not curved*, because when upon a tilt, or bearing, on one side only, the curve has a tendency to yield, when a straight line would brace, &c. &c.

Instead of the modern improvement in having Carriages *without* a *perch*, I should rather adopt *three*, although the other kind are contrived to preserve an *equilibrium*. Improvements and de-

* Impromptu, on seeing a Waggon with coal stopped on Muswell Hill.

corations may be indulged by others, whilst in the principles here offered it is humbly hoped may be discovered something of general utility and economy. In several *component* and *auxiliary* parts various *materials* may be substituted. For *roofs*, a fabric of cotton cloth, japanned, or varnished by a *patent preparation* may be used for leather. An inferior kind of leather thus prepared, with a *substitute* to render traces equally strong, and all kinds of *braces* too, may be found equal to what is now merely in contemplation*; in both instances producing an important end—the saving of hemp and flax, and leather, of superior qualities also; encouraging the manufacturers of *substitutes*, and leaving the more costly materials for other and more indispensably requisite purposes.

With respect to Wheels, if a *balanced pressure* be increased ever so much, and the whole shall rest on a *plane*, it will consequently have a *tendency* to preserve a perpendicular position. Hence, then, seeing that the elephant is designed for burden, so may Trams or iron rail-way Waggon's roll the same surface, for the feet and footsteps of this beast are nearly alike and *parallel*; and, if inclosed by right lines, will form a square figure.

Mr. C——e would seem to scout the doctrine concerning the *diameter of axes*; and in the proportions of those for “Wheel Carriages” would be governed by those of the *clock*, and other machinery, whose Wheels are “stationary, and have no other motion but that on their axis or spindle, and the power applied at *the rim*.” But, let us endeavour to elucidate this point, and see, if that very distinguished gentleman's perceptions can be properly extended to those “Wheels that *roll* on their rims, and *advance progressively*, at the same time, that they

* Traces, &c. made of wires, &c. &c.

turn on their axles?" Is Mr. C——e aware of the difference that exists between the peculiar properties of each? and has he contemplated the relative effect of the necessary power to put them in motion; in the one case "applied at the rim," and the other at the centre? "Whether Carriage Wheels can be supposed to have any analogy to the lever," has been a question of much discussion; and, although MR. CUMMINGS seems to understand the subject in an eminent degree, let us exert but a very small portion of limited faculties, and we shall be able to see *where* the *principle* of the lever, *in fact*, does apply. I had already bestowed much attention and had concluded upon certain rules for deciding the diameters of axes for "Wheel Carriages;" and whatever then remained doubtful has since acquired certainty, by the light afforded the subject from the reasonings of Mr. *Cummings*. True it is that "no advantages arise" from any analogy of the *spokes* to the lever. But may not some effect be derived from the *principle* of the lever, when the power is applied at the axis or spindle? When this *power* becomes active, does not its effect *commence* at that first or nearest *point* of contact? Is not that the *nearest point acted upon*, by which, on the exertion of the cattle, the Carriage is got into motion? Can *that point* be any other than the *front part* of the axle? And if, whilst the Carriage is *at rest*, the "power and resistance" (as applied to the body of the axle in close embrace with the box) are equal; "if the power be increased so as to give motion to the Wheel," does not the equilibrium thereby become destroyed? and, the *impulse prevailing at the front surface of the axle* over that *point of the rim previously* resting on the plane? Let us endeavour to see and point out the *analogy* of the lever acting from that point of impulse on the plane; the point of *rest*, or fulcrum, which is disturbed by *advancing*

the axle; and, by a perpendicular line dropt through the centre of the axle, we may perceive the continual destruction of the "equipoise," by advancing the *front section* of the axle, which, according to preceding principles, is *more active* than the other; hence the increased diameters of axles are confirmed*.

FIGURE VI.

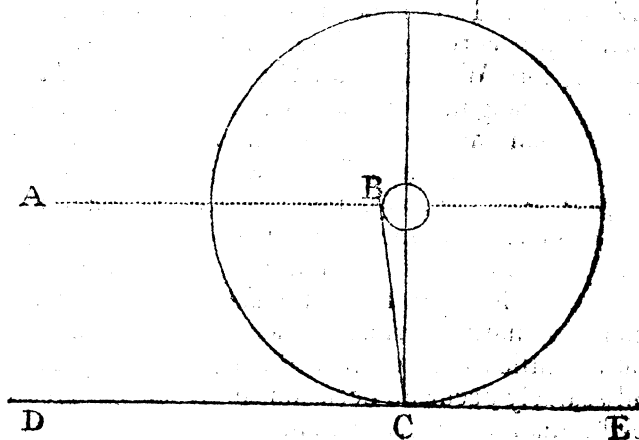


FIG. 6. A four feet Wheel of eight inches axle.—A, B, the line of traction; C, the point of rest, and fulcrum; D, E, the plane.—Scale, one inch to the foot.

The line B, C, the *agent*, or *power* applied at B, to produce motion! Here, then, the "equipoise is destroyed." And, hence the evident advantage appears of *increasing* diameters of axles in all heavier Carriages.

• Since this *memoir* has been returned from the hands of Mr. C——e, into whose it had been placed, with the hope of obtaining the favour of that respectable gentleman's *refutation*, or *confirmation* of its principles, in which expectation I have been disappointed; it is deemed unnecessary to offer a farther apology for suffering his distinguished name to remain, as it had been originally, perhaps too freely, used.

It will have been discovered in a former part of these observations, that the author was doubtful, and, at the same time, perseveringly labouring to understand the principles, and to decide upon certain laws, or rules, for the *diameter of axle-trees, particularly for Wheel Carriages*. The result, it is his pride to offer for the consideration of others, possessed of greater acquirements: and until he shall be farther enlightened by their communications, he confidently recommends such as here described, viz. The diameters of axle-trees to be proportioned according to those of the Wheels. The front or fore Wheels of all Carriages to be *ad libitum* as to height, but few occasions require greater or less than three feet. The hind Wheels of such Carriages to be regulated by the required *length of the platform, or body*, upon which the load is to be adjusted: and, increased in diameter or height, so as to form a depressed line of three degrees to the front axle; and if a little *dished*, in this particular too, nature furnishes a sure guide, for a horse that is a little *cat-hammed* is the more active. There will scarcely occur an occasion for Wheels of greater height than *four feet*, whether for pleasure or profit. Hence results the rule or law laid down in the *specification*; because the doctrine concerning time and power, is applicable to the *particular point before us*; for the lighter and quicker a Carriage moves, the better it *gains* by motion, what it *loses* in power; and, because *velocity* diminishes resistance, or pressure, upon the road.

In the formation of most Wheels, the number of spokes are equal. But, to the practical observer, an *unequal* number seems more to accord with the theory of *vibration*. In the former, when *one* forms the point of contact on a plane, and consequently a right line of *pressure*, the opposite one an equal line of *resistance*, by which the *principle* of the

arch is destroyed; and, that desirable *yielding* or vibration, on sudden shocks, is in this case prevented; when, by *diverging* spokes from the common point within the nave (and *perpendicular*) an *arch* is placed *over* the point of contact on the plane aforesaid, and by these means the *vibration* is promoted and divided, relieving the Wheel from an *unequal* strain, accordingly as *two spokes*, above described, successively are made to sustain the load. And, vice versa, these considerations decide in favour of the *wooden* spokes and *segmented* periphery, in the composition of cast-iron Wheels, as exemplified by the drawing in the *specification*.

With regard to Wheels, if a balanced pressure be increased to any given degree, and the whole shall rest upon a plane, it will consequently have a tendency to preserve a perpendicular position. Whence results a rule for the Wheels of Trams or iron railway Waggon. These may have their Wheels adapted, so as to roll the same surface: and the principle is illustrated by the foot and footsteps of the elephant, a beast peculiarly adapted for sustaining ponderous burthens.

Respecting the preceding points, they are of the utmost importance; but others of minuter consideration are not unworthy of particular attention, viz. The Venetian blinds, with inner curtains for summer, and *squabs* for winter, may be so regulated as to admit a small (or prevent any) portion of air from so many crevices or apertures, as well in the door and windows, as the quarters, to secure the greater comfort of the passengers by exposing all alike to an equal participation of its influence; the doors too, may be furnished with blinds and glass. The seat, the ends of which are at the doors, would seem to obstruct an entry into the Carriage at all, but this is remedied, by converting the *end divisions* of such *seats* into part of the steps by which passengers

ascend ; a plan which, it is hoped, will be found to possess some merit, upon an inspection of the drawing in the specification. The seat behind, and outside, intended for persons, or baggage occasionally—the baggage box *under* the hind axle-trees, if required may, be suspended on springs and both provided with jointed straps, and jacks to wind up and tighten the packages, so as to prevent *their action* ; and the driver's seat also, together with a seat for the guard, or other persons—with aprons to the two first to cover passengers to the waist, (like a common Curricie) while their heads are protected by the projection of the roof behind. These particulars may be explained by personal attention, better than by written descriptions, or an imperfect drawing.

It seems important in my view, that some attention be given to the geering or harness, by which the powers of the horse may be used to the greatest advantage, as well as to relieve, as far as possible, the distress of that noble animal. Here too it requires little more than to *simplify* the common fashion and adopted modes. Keeping still in view *his centre*, it follows of course that the present mode of reining him up is erroneous. The fixed point for this purpose is behind that centre, thereby creating a *retarding check*, contrary to the progressive and natural motion of the head in *advance*. And this, for the purpose of supporting the animal, keeping him from falling, or recovering him from a false step or blunder !

What good horseman would, upon some similar occasion, keep his hand *fixed down* to the pummel of the saddle, with the expectation, by so doing, of recovering the horse from such an accident ? Would he not rather raise his hand up, and by a quick jerk suddenly restore the animal to the use of his legs ? Whereas *contrarily* on the present plan the neck becoming stiff by being *braced* to the *fixed point* be-

bind his centre, produces the effect of *dead weight*, or pressure from this *fixed point* to his mouth, operating thereby like the chord of an arch. Hence, then, I would prefer the top of the hames, as the better point for fixing the bearing rein at, or *upon the point of his centre*; leaving thereby more to the skill of the driver, himself supporting the *levers* by *his* exertions and strength of arm, rather than suffering the rein to lie negligently loose and extremely dangerous. This exertion of arm furnishing continual and *varying* support to his team, as the continually *varying* occasions occur. The principles here supported apply in reference, in *some particulars*, to all Carriages; and none seem more to require their application than Post Chaises; since, to the least attentive passenger, it is evident, that the powers of the two horses in them are never in *concert*, to produce an *united* effect. The postillion's horse is generally the stoutest of the two; and this is necessary, since by the natural and incessant inconvenience to the rider's *right* leg, he makes his horse pull most. Hence the *once* stouter animal, from *abuse*, is degraded to the station of a *hand horse*, where, incessantly *touched up*, he is able to do little more by his efforts than serve as a counterpoise, by *jerks*, to his partner ever on the stretch.

The hitching of traces to the shafts in either Waggon or Carts, in the common way, is evidently an error, since no *form* of a *body* for drawing can be conceived *better* than that of a *wedge* or *cone*—if in the former (*viz.* the Carriage) the centre of its *edge* is the proper point; in the latter, no doubt, from *its end*. And if we reverse this scheme, and *propel*, instead of *draw*, at what point could we strike so effectually, as precisely at, and upon that centre?

If, in the construction of Wheel Carriages, the design is to provide a *progressive* motion, and that

too with the greatest speed and least possible labour; who that possesses ordinary perception, who capable of reflecting upon the unerring laws of nature, and observing her simple operations, can for a moment doubt of the superior claims of the wedge-form Carriage? Can there be a surer guide to the attainment of our object, than a strict observance of *first principles*, and the application of *practical* discoveries, rather than forming visionary theories? And, if, as in decency we are bound to respect *customs* and *opinions*, however absurd; and whilst too we cannot but admire the ingenuity of our ancestors, whose duty has been so well performed as pioneers, clearing the field of science by their bolder enterprizes and primitive talents, whereby posterity have gained so much wisdom and experience; we should pay little respect to their memories, and less value their exertions, were we not to *improve* upon their discoveries. Nor could our own claims to approbation be justified if, contenting ourselves with what has already been accomplished, we prostitute the noblest attributes of God, by an indolent enjoyment of those fruits already provided; when by our activity and exertion we might render them more gratifying to man and acceptable to our Maker!

Observe then the horse, the noblest of the brute creation as well as the first in order; and destined to aid man in the attainment of his various purposes; see also the stag, the hare, the fox, the greyhound, and the whole tribe of quadrupeds; observe the fowls of the air, and the fishes of the sea! and among those latter *whose necessities* alike require swiftness of motion in the pursuit of their prey; and who, that investigates their *formation* and attends to their *action*, cannot but perceive the wedge form? Why then should we not construct our *Machines* upon principles of convenience, by assuming, as far as might comport with *reason* and

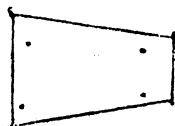
experience, similar forms? and not only in their *form*, but in the adjustment of the burthens they are designed to transport? Here then, let us *first* remark a Waggon loaded with a large piece of timber, or trunk of a tree! the butt-end placed in advance, and, perverting the order of things, *this end* is elevated as far as possible; taking care, at the same time, that it shall *not actually slide down behind on its inclined plane!* And is there not some degree of ingenuity usually displayed to *prevent this effect?* Every waggoner answers in the affirmative! Can it, therefore, be necessary for *one, combating present errors*, to *reverse* the proposition? and demonstrate the corollary? Has any one marked the track of the horse, the stag, the fox, the hare, or the dog, upon the snow? has he not seen that by drawing *three* or four right lines to enclose these *tracks*, that a triangle, or wedge, is the only possible

figure to be described, thus



? or

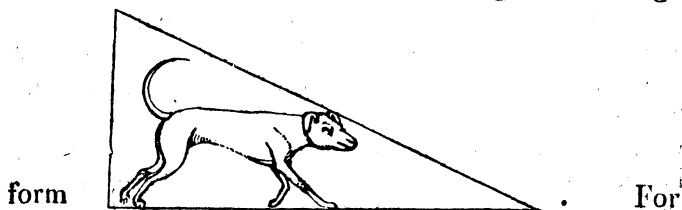
in this manner



? And after duly

considering the proposition, who is so ignorant, as not to apply the same reasoning to the *fish* swimming *under* the surface of the water, the fowl hovering upon the surface of it, and the bird passing through the air! In all such cases enclose the figures in like manner, and mark how much more agreeable to nature will *such lines* form an external figure of animated motion! And mark too, *where* the acute angle or point of the wedge will be found! Nor stop at this point: draw the *profile* of *all these several* animals when in motion. Let them be in full speed, and by drawing

lines, as in the *other cases*, mark again the wedge



the motion of the *tail* in the dog, fowl, and fish, vibrating and expanding, exhibits the *form* of the larger end or back of the wedge; as may be *proved* by viewing its utmost limits, when excited to produce its destined effects; like the spreading out the hind legs of quadrupeds to insure their propellency and steady progress.

MR. WALKER, guided as he presumes by the unerring laws of nature, would claim attention for being correct in his principle of the *horse's shoulder*, forming a base from which his perpendicular line of traction descends to the splinter-bar: and if the horse was merely to furnish a *lifting* power, there could be no ground of dissent from this hypothesis; but, since he is to *draw* according to different schemes of power and equipollency, viz. one pair of horses are to *draw* from a *certain point*, upon a level with his centre; and, since it is evident, that a man can pull more *down*, than he can *upwards* with a rope, by means of his weight, and *undulatory power too*; why should we not avail ourselves of this advantage, by resorting to the old fashioned harness with *breast-plates*, for the Wheel-horses? leaving the others drawing from the pole end, to *lift* by means of the collar and hames aforesaid, to which principle Mr. W.'s theory certainly is meant to apply. And MR. ORR appears equally just in his conclusion, that the *ox* pulls *downwards*. MR. GIDDY seems to have reconciled this comparison. Here then are two opposite considerations, confirming the ideas

demonstrated in FIG. IV. for combining the *lifting* with the *tractive* power. And since my observations arise from observing the course and conduct of nature, and finding that the horse is destined for ornament as well as usefulness, and that the ox, whose form, motion, bulk, &c. &c. designate him solely as the beast of burthen; it seems consistent to apply to the present purpose the manner in which his properties may be profitably employed. Still mindful of the superior ability of the horse, and the greater variety of purposes to which that animal can be applied; for in him are combined the many qualities, and some of them exclusively so, requisite and connected with our present investigation.

If a prohibition were to take place of taking so much luggage on the top of the Carriage, or the *maximum*, (never more than six horses to a Coach; nor more than five to seven in heavy Waggon; and three for a Cart, at the furthest; if oxen, five—drawing *tandem*) were to be disputed by Coach-proprietors, as probably would be the case, from its curtailing *their* profits, it may be fairly replied, that *others* will be benefited by the employment of *more Carriages*, and supernumerary horses; thereby producing a greater public advantage by a far quicker communication, and less injury to that noble animal the horse; and to the less damage of the roads and “High-ways.”

Reverting to the hints afforded us by nature, I would just observe a man hitched to one of *those three-wheeled chairs*, used by invalids at Bath; let *his* traces be fixed upon a level with its front axis, and his breast-plate left free to find its proper point of *resistance*; *his* centre, somewhere about the heart, as in the *horse*, will be readily discovered; and at *that point* will he find the least difficulty in drawing: yet, possessing more of the *lifting* power, by such a position, than that of *draught*, if the hind Wheels are fastened at their point of contact

with the plane, so as to be immoveable, *his* continued efforts, if sufficient, will be exerted to *lift* completely the 'fore Wheels from the ground, until their axis forms a line with the rear axle-tree—Vide FIG. IV. But, if *another* line of traction be extended from some fixed point, either of the passenger or body to be drawn on the machine; or, from an *upright stanchion*, contrived for the purpose, to the *centre* of the *agent* operating *there*, let this line *fall* and form an angle equal with that from *below*, in that case would be seen, the true point of fixture, combining the powers of *lift* and *draught*. But, as before stated, if the road be always a perfect plane, then, the *medium* or the *centre* of *gravity* reasonably occurs to our senses, as the desired point.

To those who insist on the ill effect of a true cylinder operating upon roads, even of *four* inches bearing, with “rounding off the edge;” and would calculate this as minutely as a model to run on a *curved* plane, it may be proper to reply, that both considerations vanish before the *practical observer*. For, nature compromises, and accommodates, all such minor considerations.

Since *theorists* have deemed it important to “round off the edges of the tires of Wheels,” with the view of an *essential improvement*, as set forth in certain *refined* and *visionary* particulars, surely we may, with equal propriety, venture to *expose* the error, and the barbarous consequences of the ill-constructed and misapplied “*prime plant*,” or, fashionable whip; and recommend a return to the old fashioned *practical staff* and *thong*; united by means of a loop, allowing a *fall*, or *balance* to the *sufficiently extended* handle—the judicious application of its *weight* causing the animals, at *proper intervals*, to *feel* what will stimulate them to effectual efforts. Instead of which, the *unceasing pecking* upon the off shoulder, by *excoriating*, until a *callus*

is formed, enables the animal to resist the vain repetitions! Is not the *end* of such handles the *place to hold* the whip? Look at the present ridiculous fashion! *the end resting* on the driver's knee! the *long, light and unmanageable* thong, tapering from its union with the staff, doubled up into a *bunch* in the hand, from whence it must be flourished *indiscriminately*, thus affecting all, instead of a *particular* horse.

It is more advisable to adopt the Carriages here recommended, since their *principle* perfectly coincides with the improvements, lately contemplated by government for high-ways or public roads. And if such improved roads*, are likely to facilitate the progress of the present Carriages, how very great will be the advantage derived from altering all Carriages for this great and combined purpose, by *reducing the front springs*, adjusting *the distance between the axle-trees*, so as to obtain the *angle of three degrees*, &c. &c. as far as they severally may admit, according to their present form and construction!

"MR. GRANT" seems to have an idea of a different length of axle-tree. But, if he had reflected sufficiently on the invariable powers of the *wedge*,

* Note well A. Appendix (C) No. 1, "to the Report from the Committee, relating to Broad Wheels and Turnpike Roads," shows a national saving by certain improvements of 5,057,500*l.* annually! Taking the liberty then of using the same *data*, and confining the estimate to a saving in horses, belonging *solely to Waggon*s and *Carts*, it is believed that "the *improvements in Wheel Carriages here set forth*, will operate to a saving of *eight millions* per annum!" For, Waggon's now take seven ton in winter, and eight in summer, with nine and ten horses, *inclusive*; whilst, it is not too extrayagant to *expect*, that five horses in those Waggon's so *improved*, will draw *five tons*! and *Carts* in an equal ratio. And, all this in the present state of the *high-ways* of the kingdom: not to mention the immense sum that might thus be saved which is proposed to be voted for their improvement.

though imperceptible to *common* sight, he would not have recommended that "fore Wheels should be the full breadth of the rim, either nearer to, or more distant from each another, than the hind Wheels." He certainly would have adopted the principle here contended for, the wedge form. For, does it not seem consistent that the smaller Wheel, and its *associate powers*, shall sustain diminished weight? If this shall seem to contradict a former remark, let the final result for the shape of the *Mail Carriage*, in the wedge form be examined. Hence then an important difficulty is solved, a desideratum obtained, and the *wish of Government* satisfied—the *advantage of Wheels rolling different surfaces*.

The load too, by the adoption of the proposed plan, as far as consists with accommodation, may be placed upon the *descending line* of pressure. These considerations have induced me to conclude upon the eligibility of the *wedge form*, and the *lever*, manifested by the lines of *pressure* and *traction*. And does it not coincide with common sense that, *higher* Wheels, necessarily made proportionably *stouter*, ought to sustain the greater weights? proceeding on the continued principle of the wedge; which it is our aim to introduce into practice, as far as comports with utility and convenience, according to varying and incidental circumstances. That gentleman's plan for altering axle-trees, with singular propriety, and profit, may be realized, and made to correspond with these *principles*. MR. ERSKINE'S "observations" that horses abreast draw more than when yoked at length, confirms these principles. And, in Carts the plan of *one* and *three*, as before stated, is now manifested.

The "proposed regulations relative to *Stage Coaches*," which have come to the author's notice since writing the preceding remarks, tend to corroborate these principles.—"Outside passengers," be-

ing limited, and the *risque* of the present fashion avoided, the number of insides will be increased in due proportion. And the figures hereafter to be referred to, demonstrate the provision for luggage, by means of what may be called "*sub-imperials*," taking "fully as much bulk" and weight "as is consistent with the preservation" of those advantages, so unremittingly aimed at in these memoirs.

MR. J. C. HORNBLOWER's observations have been also anticipated, and his suggestions brought into view; and, this coincidence of opinions tends to confirm these principles.

MR. WATERHOUSE will find *this Coach*, or Carriage, equally high in its platform, and consequently equally *dry* for the preservation of goods.

In order to evince the truth of the *propulsive effect* previously conceived, created, and employed, it may conclusively serve the purpose to observe the *repulsive* and opposing *re-action* of the high arched fore springs in gentlemen's pleasure Carriages, and thence decide the merits of others, which will hereafter be shown to possess the greatest utility; and at the same time capable of yielding an equally agreeable sensation to the passenger.

It may be necessary however here to anticipate an objection that may be started to the use of *three perches*; for although they admit not of very short locking or turning, yet, the Carriage may be turned from one street into another, whose several widths are only twenty feet, and this too, with four horses in hand. True it is, that the operation requires *more time*! But what will perhaps more than balance this inconvenience is, the *humanity* of a regulation that would compel coachmen to stop! or, to turn all corners slowly, lest by a different conduct some passing foot-passenger be incommoded, if not knocked down, and seriously injured; or the Carriage itself upset! For such accidents certainly have

occurred, they do occur frequently in the metropolis, and should be provided against by *every possible* means.

ADMIRAL BENTINCK's information, as to the "Nelson Coach," confirms the truth of an original observation on this subject, where on *driving down* hills it is absolutely necessary to increase the velocity as far as possible, to prevent the overturning of the Carriage! &c. &c.

It might be well to consult MR. HASKER, and obtain his ideas as to the merits of the principles, and construction of a Carriage, here set forth; and I would most respectfully solicit his opinion candidly on the subject, whether it can be made lighter with safety to the Coach, and passengers, more especially considering the difficulties of travelling in the night-time? It is consistent with every consideration belonging to the subject, to remark, that, whether with respect to the smaller Carriage, the altered Post Chaise, or any *new ones* to be built for *such* purposes, and the *Mail* Carriage more particularly, there should at all times be a companion with the driver: and as the motive is, to have *aid* at hand in case of accidents, this passenger should be of his own choice, or the one approved by consent of parties; *all* of whom are interested in the selection. And the largest Carriage should never have more than two, including the driver; for, a greater number would be *increasing*, rather than *diminishing*, danger.

MR. VIDLER's notions, so far as he has been consulted upon this subject, still leave us to determine upon certain *rules* for the *diameter* of axles; and, his objections to the increase in their *length* and *weight*, do not discourage us from the hope of accomplishing this end hereafter.

The rude original sketches Figs. I, II, III, it is presumed, will place the errors of the high Coach,

now in use, viewed either travelling up, or down hill, or on a plane, in a conspicuous light, and at the same time support the projected plan.

Bringing again into view, the *three-wheeled, Bath Chairs*, in order to support what has been said of the effect, produced by the application of certain powers to, and points of, the *wedge* and *cone*; what would be the reply of the most ignorant porter, if he were asked the difference between the quantity of *his* power or *momentum* applied in *drawing from* the front axle-tree, and that of *pushing* from his *accustomed point on the back of the vehicle*?

I feel too much respect for the *patentee*, the Rev. MR. MILTON, to offer any comparisons between the advantages of the *machine* under contemplation, and that, which *he* has so ingeniously offered to the honorable Committee of the House of Commons, to whom it belongs most properly to decide.

Finally, should these principles possess sufficient merit or plausibility as in a reasonable time, and under any *circumstances*, to insure their being brought to the test of experience, the Author confides in a successful issue.

However fallacious the premises, and however erroneous the deductions, it is said that "we must not attack MR. WALKER." And, yet, who could forbear to exhibit the absurdity of the highly loaded Coach which meets *his* unqualified approbation? And who among practical men, will be found still to persist in the error, after viewing the FIGS. I, II, III, exposing so clearly the serious objections to such a practice?

MR. K. another gentleman of very distinguished merit, insists that "the more the point of the axle is bent down, the better!" If indeed the *Coach* is designed to sustain a vast weight only; then the *principle* of the *arch* may be carried still farther.

So too, a man who is *bow-legged*, possibly can bear a greater weight than one, who is as straight as an Indian; but how fallacious will such doctrines appear in a trial of their comparative swiftness! This gentleman also is an advocate for elevating the load, as far as possible, even to the extravagant idea of its assuming the form of a column, erected upon the floor, or platform, of a four-wheel Carriage! And in aid of this theory instances, a common Waggon haling large trees from a bog; on which occasion the load is necessarily mounted aloft by bolsters, &c. &c. each end projecting fore and aft! True! But mark where lies the deception! The elevated load produces an effect, which, if not misconceived, is *caused* by the *principle* and power of the *lever*! Here then the ingenuity of those gentlemen might have been well employed, in contriving a mode for applying the efforts of the team at the *acting* end of the lever, instead of the present *point of traction*, the *resisting* end; and after effecting this purpose, might not the fallacious contrivances for combining the *lift* and *draught* have been perceived? Still pursuing such reasoning, how gratifying would be the result of an experiment, whereby the real effect of suddenly stopping the hind Wheels and continuing the draft, until the *true* line of *traction* was formed, *from that* point of *resistance* and contact on a plane, to the point of draft, the horse's centre thence estimating the multiplied, and worse than useless, efforts towards *propulsive* motion! For it surely is necessary to comprehend the several causes, and effects of such cases, before we can prove the improper point of *draft* at the splinter-bar: after which may we not detect the *hammering* of the fore Wheels on the road, a reason greater than an *increased velocity*, for these wearing faster than the hind ones?

OF LOADING.

WITHOUT being either a "Waggoner or Carter," every person at all concerned in Carriages, influenced rather by *prejudice* than reflection, insists that the loads of every Carriage should be placed as near as possible to the cattle. But, why or wherefore, is asked of those best skilled in such affairs? Has any one fully contemplated the combined powers of the *lift* and *draught*? Does he not perceive that by reason of a continued *tendency* to *lift*, drawing from the axle-tree, the *weight* is necessarily laid *upon that point*, that its *pressure* may *counteract* such tendency? And, does not the pressure *thus fixed* neutralize the *repulsive effect* produced by the efforts of the team *upwards*, from the termination of the line of *incidence*? An effect equally produced by placing the load on the after axle-tree or fulcrum? Hence, is it not apparent that, if the point of *traction* be *from the line of gravity*, and adjusted to the centre of the cattle employed, still mindful of the *principle* of the *wedge*, when *once* in motion, is not its *impetus* increased consistently with its well defined and powerful properties? For, does not a *wedge* penetrate with greater facility in proportion to its *weight behind* the edge? And, is not its tendency to *motion* increased by its weight also? And, according to the view I have formed of the theory of *falling bodies*, that would seem to apply, in a certain degree, even in the very *oblique descent* of the wedge principle, here adopted. If these remarks have any claim to attention, may not the Mail vehicle, designed, and

exemplified in the drawing, be found to possess some small portion of merit? And, if applicable to such a Carriage, may not the same *principles* be realized in the structure of every other, either for pleasure or profit?

How cruel and absurd then must it be, still to persist in old errors and opinions, and persevere in continuing to distress and worry the noble spirited horse, by requiring of him worse than useless and continual exertions to *lift* by his *action*, whilst it *must* be by his *re-action* he performs the task of dragging along, however happily disposed, an oppressive burthen!

Is it not therefore manifest, that, by a judicious arrangement of the load upon the *foundation*, or platform, supporting its gravity, that portion which is placed *behind* the after axle-tree, or fulcrum, performs the operation of the lever from time to time as obstacles occur, however minute, facilitating thereby the purpose of *lifting* the front Wheels without imposing *dead weight* on the team, as in the usual way of hitching the traces to the splinter-bar?

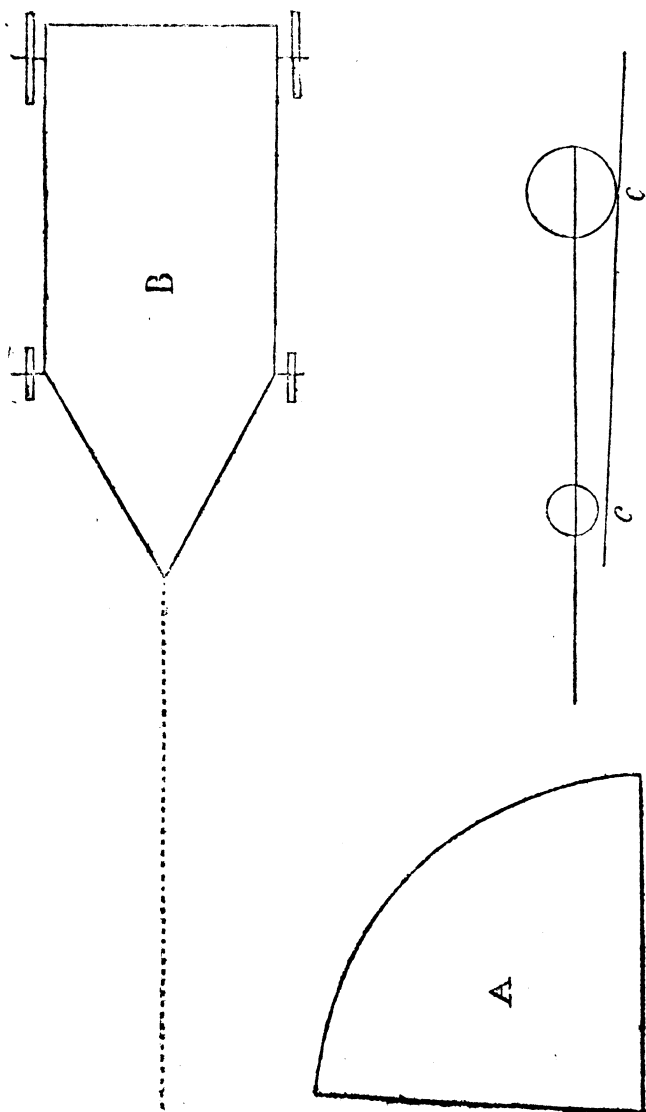
Respectfully mindful of MR. WALKER's experiments and intelligence, I must crave the Reader's indulgence and his pardon for further considering his theory on the *properties of the horse*. And, since perfection in science is not an attribute of humanity, may it not be, that whilst advocating the *form* of the *shoulder*, doubtless well calculated from which, as a *base*, to *drop a perpendicular*, a *justification* is rather *sought* for the *indiscriminate* use of the *collar*, which long habit, or, unaccountable *prejudice*, seems to have confirmed? Can it not be equally maintained, that the *joints* of the shoulders, forming the *breast*, by means of the several *short joints*, or *levers*, uniting and combining *larger* members of the frame into a *breast-work*, where, seeing that *this machinery* is more *limited* in its

action, a firmer and more *irrisistible base* is provided for the *resistance* necessary to be overcome? And, if as before, a man, by adding his *weight* to his other physical power, can pull more on a rope, is it not a conclusive apology for reverting to an *improved* old fashioned breast-plate, at least for the Wheel horses?

In order to *ascertain* the *principle* of the *inclined plane* of *three degrees*, adopted as the basis, and here elucidated so far as to demonstrate its *practicability* on the present occasion, a small *carriage* and *block*, as per FIG. VI, were provided; and a pulley too. This block, A, at first sight, would seem to be a *quadrant*, or, in its profile, the fourth of a circle. But, it lacks *three degrees*; and, these are supplied by the aforesaid Carriage, or *platform*, upon four Wheels, marked B, whose *axles* are cut by the aforesaid line of graduated *inclination*. When this *block* is placed with either of its *plane sides* in front, or upon the fore axle, and consequently, the other, upon the *platform*, a *true perpendicular* will be found, formed from its summit to the plane on which the Wheels roll, C, C. In this position, a *given weight* was suspended "over a pulley," elevated to a *proportionate point* of the *supposed horse's centre*; *lifting* from the axle (as in the present Coaches). *This weight* being unequal either to *lift* or *draw*, the block was *reversed*; and the *curved* or *arched side* placed *before*; the under side on the platform as before: *this same* "given" weight, upon the same pulley too, put the Wheels in motion, *promptly*!

Next, to shew the effect, and to *prove* the *error* of springs acting *laterally*, or, crosswise, as in the *same Coaches*, the block was placed upon its *curved face* or side, *crosswise*. The before-mentioned weight, and pulley, the same; the Wheels *were* put in *motion*: but, in proportion as the *rocking*, or *vibra-*

FIGURE VI.



tion increased, so did its velocity diminish ! Again, the block was now, as in the former case, placed upon its *curved face*, equidistant from either axle-tree; but, *longitudinally*. The weight, pully, &c. in all things equally the same as in the other preceding cases; the Wheels were set in motion by the weight. But, by *minute attention*, in that *instant of time*, when the *agent* was discovered, so did the *disposition* of the block, conforming to *mathematical law*, manifest a *tendency* to get *behind the centre* ! And, equally proving the *advantage* obtained by the *inclined plane*, counteracting that *disposition*, the *velocity* of the Wheels *was increased* to a sensible degree: thus exemplifying a mode by which *action* may be rendered in these cases *less than reaction* ! From these considerations, may not the *wedge form*, and the *propulsive effect*, contended for throughout, receive a reasonable degree of support ?

This experiment teaches at the same time, that if iron rail-roads for Trams or Waggon were *raised*, or the *track* for the beast drawing them, were *sunk*, so that *his centre of draft* was precisely level with the *front axle*, giving him the aid of his *weight* by undulatory motion, his power would be greatly increased. Wherefore the ox, drawing by the forehead as in Spain, or, by an *inverted* collar and hames, is most appropriate. And, seeing that the elephant is calculated to bear great weight, and that his four feet being inclosed by right lines form a square figure, so may the Wheels of these Trams or Waggon run parallel. (If a doubt had been entertained of the great advantage sought to be produced, and continued by means of what is here considered the *propulsive effect*, counteracting and *neutralizing at the least*, that contrary "*endeavour*" which *gravity* is ever known to *accomplish* in Carriages of the present construction, but more

particularly to be perceived by the *elegant sea-springs*; this obstacle vanishes by the perusal of "page 143 of the Appendix to the Third Report of the Committee of the House of Commons, &c. &c. &c." where MR. ORR not only flatters the pride of the Author by condescending, and, as it would seem, to have *taken the hint from him*; but *confirms the principle*, by an "*addition to what he had already said in the Memoir on Wheel Carriages*;" the consideration of which said original Memoir had been most *acceptably* committed to the Author by Sir JOHN SINCLAIR; the honor of which had been *attempted to be compensated*, by an humble submission of his own rude and unfinished, and desultory reflections, upon the same subject.)

But alas! how shall we dissipate that cloud which envelopes the mind, or effectually combat an evil so generally owned, and yet so feebly resisted! Can it be hoped, that so feeble an *instrument* shall prevail, as now dares to use the *wedge* to perforate, and the *lever* to rend, that *prejudice*, which, for ages has been *rivettted* upon the *vulgar*, and acquiesced in by the intelligent? by those *simple* and *common lights* which nature incessantly offers alike to the attainment of all ranks? It may appear more presumptuous than *discreet, unpatronised* and isolated, thus to attempt an enterprize, begun in doubt, pursued under *discouraging circumstances*, and now thrown upon the world, an *unprotected* shivering bantling. Yet, thankful for limited lights of science, and depending on the prevalence of *truth*, we shall trust the issue to fair experiment. But, *the Wheels roll different surfaces!* And, to innovate upon *philosophers, mechanics, and profound academicians!* temerity is a term *too mild*, to characterise such a project.

Still preferring to reverence nature's more perfect laws, and *juster proportioned machines*, to the se-

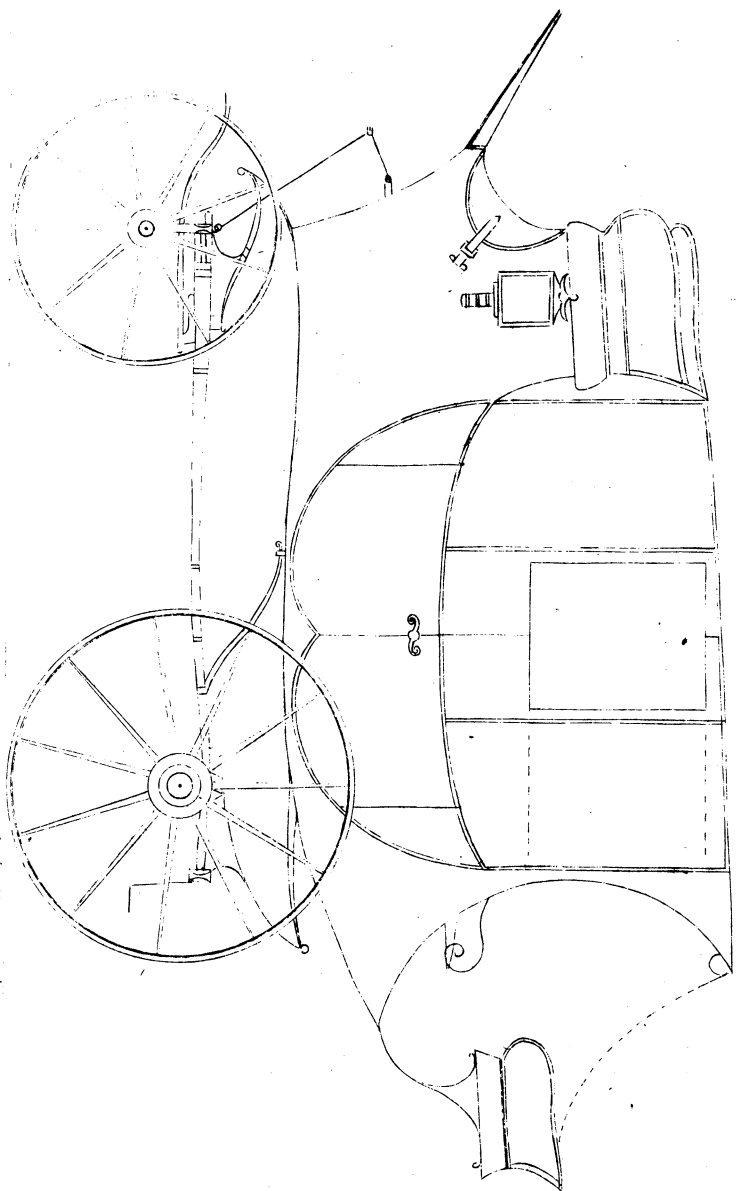
veral purposes for which *these* are designed, let us in pitying the arrogance of those, whose *superior acquirements* forbid them the use of what *the beggar enjoys*, simply contemplate the *horse*, the *ox*, and the *dog*! Do either *tread* continually in the *same track*? The first cannot *encounter* a bog so effectually with half the *bulk*, as the *ox* with his *cloven* feet; expanding for the purpose of bringing as *many points* as possible into use, the better to sustain his weight and pressure! Whilst for *similar* purposes, the claws of the dog are so wisely contrived, as to *pass*, and *gain* what shall be *inaccessible*, and *impassible*, by both the others! But it may still be urged *these same* Wheels “will be difficult to get, or drag out of the ruts!” It is a sufficient reply to ask, how *these ruts have been made*? It may close these remarks, by insisting upon a conclusion evidently resulting from Wheels not running in the same track, that common and *reciprocal* advantages will be derived, both to the *roads* as well as *Wheels*.

CONCLUSION.

SPECIFICATION OF A PLAN FOR THE CONSTRUCTION OF WHEEL-CARRIAGES IN GENERAL, UPON A PRINCIPLE INTIRELY NEW.

THE *height* of 'fore, or front Wheels of all *Four-wheel Carriages*, the length of their axle-trees, and breadth of platform, or base in front, on which the body, or load is intended to rest, or be supported, may be, *ad libitum*. The *distance* between the two axle-trees, to be regulated according to the different purposes and uses for which they are designed, requiring longer, or shorter *platforms*, or *bases*; and consequently an increased elevation of the hinder Wheels, by having respect to the following particulars, thus—measure such requisite distance between the front, and the hinder axle-tree; then elevate the Wheels so as to form an *inclination* of *three degrees* from the centre of such hind Wheels, to the centre of the front or 'fore Wheels. And *their* relative, and proportionate *heights*, will be thus respectively ascertained. The *length* of such hinder axle-trees, and correspondent platform, or base, may be known by drawing a straight line from the centre of the front of such platform, or base, to the end, or hinder part of such platform or base; then, extend two other parallel right lines from the extreme points of the front, or 'fore part of such platform, or base, on each side of the aforesaid *right* line, and expand the same from the commencement, at the *two extreme points* of the *front* and *width* of the platform, or base aforesaid, so as to obtain

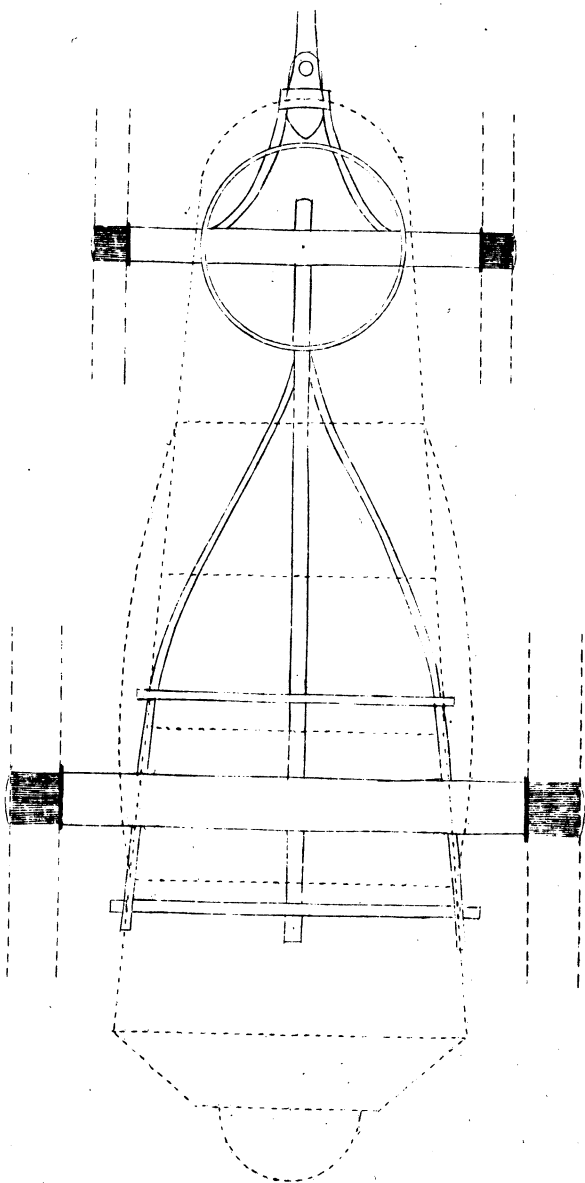
A



1. Carriage del. 8. 4. 1.



B





TO THE READER.

Other Plates and Drawings alluded to in this Pamphlet, could not be prepared in time, from the circumstance of their having been detained too long in the Enrolment Office, where they may be seen, as also in the Repertory of Arts: and, if the present Treatise is favourably received, another Edition shall exhibit the whole Drawings upon the Subject, together with certain additional Observations.

are affixed; so that the Wheel horses attached thereto, may with facility turn from side to side, in *concert* with the pole and leaders; by this contrivance the one pair *solely* draw; whilst, by means of the pole (the line of *reflection*) the others simultaneously *lift* and draw, and thus effect what is so desirable, a *combination of the powers of lift and draft*. Pole-pieces, or breast-chains are used to hold back, and to guide such Carriages, in the usual manner.

The axle-trees are to be constructed of wood, or metal, according as circumstances may require. If of iron, or other metal, to render them lighter and equally strong, they should be *hollow* at the arms, or, those portions of them, that rest in the boxes of the Wheels, and on which the latter turn: into the ends of them may be inserted screws with washers, or other contrivances suggested, with or without *linch-pins*, to confine the Wheels from running off. And, at the other end, or shoulder, *washers*, or other means may be adopted to confine the inner *surface* of the shoulder, or inner box, from working inwardly, and *out of* its proper position, in a manner similar to those at present in use.

In the formation and adjustment of the necessary springs to all Carriages, whether for the Mail, Coaches for the conveyance of a large or small number of passengers, or pleasure Carriages of every denomination and quality, having close or open bodies, with four Wheels; the *front* springs must rest for support on the bolster over the axle-tree, and *after-bar*, or other pieces of timber, calculated for the purpose of supporting springs in the usual way; but these are to be *curved*, or arched forward, projecting twenty-five degrees in *advance* of a perpendicular line, drawn through the centre of the Wheel, on its axle, that forms the *base* of a true isosceles triangle, described from the aforesaid *project-*

ing point, to the *top* of the *curve*, or arch, where it is *intersected* by the fore-said perpendicular line.

In this state, and position of the spring, it is understood to be *at rest*, the Carriage not being *loaded*: leaving the space under the curve, or arch, sufficient for the required flexibility, and *propulsive action* of the spring. The body or platform of the Carriage is to be supported by *arms*, or stays, *curved* according to convenience, taste, or fancy; attached to the platform under it, *at* that point which is *precisely* perpendicular to the centre of the Wheel aforesaid; whilst the hind spring may be extended from the *front seat*, within the body, so as to support, and steadily preserve, the *platform*, as nearly as possible, parallel with the line of *inclination* previously described: the *projecting* and lower point of such arm, or stay, to be united to the projecting point of the spring, in the usual manner of junction. In constructing the hind springs, for the purpose of keeping a *propulsive* effect in view, the necessary *springs* and arms are *reversed* in their mode of *attachment* to the several bodies; the *platform*, or the *frame* of the Carriage; and also in their *projection*. These are to be fastened to the platform beneath; the *base* of the spring, *forward* in its point of contact, must be *precisely* perpendicular *over* the centre of the hind Wheel; extending the same to the common line, on which the *hinder part* of the *back seat within*, and that of the *outside* (see the plate) have their bearing and united pressure; thence curving *upwards* to the line of *inclination* before-mentioned, they are to terminate under the front part of the *back*, and *outside* seats; where, meeting with the *stays*, *branched from* the frame of the hinder part of the Carriage below, and elevated to the aforesaid line of inclination, they are to be united, in the usual way which springs are, to stays or *shackles*.

Whence it will evidently appear that springs, so constructed, must inevitably produce *propulsive* effects.

In order to check any sudden shocks, longitudinally, or otherwise; but more particularly to *counteract* any extraordinary jerks, or overstraining by the *Wheel* horses, upon the *tractor*, a jointed *cheek-brace* is attached to the front bar of the hinder frame of the Carriage, and *foot* of the jack, or stay, supporting firmly the hind spring, and extended to the platform, precisely at the point *under* the *fore* part of the *front* seat, where it is united; in a mode similar to that adopted in grasshopper-springs. Or, if, on trial, this *cheek-brace* can be made to aid the effect of springs at the same time; it will in such case answer a double purpose.

The profile or external figure of a Carriage, designed for the *Mail Vehicle*, is thus briefly explained. The foot-board may be varied according to fancy in point of form, its width *over* the axle-tree, however, must be so regulated, as to allow sufficient space *between* the platform and interior end of the hub, or nave of the Wheel, and elevated *ad libitum*, beyond the *tractor*, or point from which the Wheel horses draw, which is in a general view to be at *four feet above* the plane on which they stand; or travel; but this point of traction must be varied according to circumstances, depending on the centre of the higher, or lower cattle: and this rather by altering the height of the fore Wheels, than by any other expedient; a consideration which is of the first importance.

The Coachman's seat must be wide enough for two, elevated eighteen inches above the line of *inclination*, and *seats*, already noticed; the same may be accommodated in any manner, as far *back* as a perpendicular line parallel with the one already mentioned, through the centre of the Wheel; and formed

at twenty-one inches, more or less, as appears most eligible, leaving all that space in *advance* of the said *last* perpendicular line, to form a boot for the stowage of parcels, or other luggage. This last perpendicular line forms the front interior of the body, and *back* of the *front* seat. The *door*, sufficiently wide, is hinged nearly to the above perpendicular line, and opens at the *end* of it: one moiety of which *seat*, forms alternately a *step* that folded up supports the end of such moiety, by resting on the sill of the door. The seat is in two divisions, united and supported in the middle, by a perpendicular fixed frame, receiving and confining an *union-swivel*, upon which to slide up and down in forming the *steps*, and *restoring* the seat, by two bolts *under*; forced by a spring, *out* of place, when unfolding; and, *in* again, by folding up the step (after having been thrown down and used as such); which being then confined by a clamp, keeps the bolts thus *forced back into* the upright frame, and made to support the seat as aforesaid, by being stepped on knobs or points on the sill.

The *cushions* are divided, or jointed, like the common mattresses; the person keeping his seat, holds up the division of the cushion, belonging to the rising passenger, who opens the door and lets down the step with great convenience and facility. For further particulars see the drawing.

The space forming the side, or wall of the body, furnishes space for a window; and the remainder of such *wall*, or *side*, to be stuffed and lined as usual, except as much as will admit of *quarter* blinds, glasses, &c. (for longer bodies than this) as per drawings; or, other forms, if preferred, may easily be adopted. The windows in the doors, permitting the hand to be put out to *open* the door, which is *locked*, and made perfectly safe from accidentally flying open, by the *under* part of the *window*, from which

a bolt projects into the opposite side. These walls, or sides may be *swelled* out, and made to assume any appearance, keeping in view the *wedge-form base*, on which they are erected. The hind seat within the body, forms a box for the Mail or other purposes, the front part of it being extended to the extremity of the platform behind, where it opens at the termination of the same, and front part of the outer seat; exposed to the eye of the *guard*, who sits upon an elevated seat, hinged or jointed to the end of the platform, or otherwise; the floor of which *additional* fixture, extends one foot, more or less, to a point, where a second joint, or hinge connects it with another, but flexible support, united to the stay on which the back-springs of the Carriage rest (or as per plate). And, upon this *additional base*, which forms a floor common to the passengers on the *outside* seat, and to the *guard*, may be constructed *his seat*, or otherwise; or, if for *several* persons, equally wide with the one in front of them; which by the *expanded form* of the body, and, not *being stuffed* or *lined*, may be capable of containing three or four; whilst the seats *within*, are calculated only for *two each*.

The form of the body in a profile view *behind*, is *curved*, in order that by the *projection* of the roof over the hinder *outside* seat, the *heads* of the passengers, or the luggage, if substituted, may be defended from the weather. A curtain dropped from the point of *such* projection in the roof, forms an additional defence, and at the same time, an *apron* for the *elevated guard*, whose seat enables him to see around him in every direction.

Among other serious considerations for *seating* outside passengers below, is, the principle in this mode of constructing Coaches, allows nothing ever to be placed on the *top* of the Carriage; for who ever freights a ship on the deck, instead of stowing

her cargo in the hold? In pursuance of the idea of never permitting luggage, or persons to be placed on the top, but wholly confining, as is evidently proper, (except imperials) the load to the line of *draft*, as far as practicable, the principal framing, both of the Carriage and the body, requires every degree of *strength*, and consequently, must be relatively *heavy*; whilst in every thing to be contrived and adjusted *above* the line of *inclination* or *bearing*, every respect possible should be paid to render the body *light*. The roof therefore may be covered with canvass, cotton, or other light fabric, varnished over, or made water proof with Paqualon's patent or any like composition.

It seems superfluous to remark, that the preceding particulars being understood, various larger or smaller Carriages may be constructed upon a similar plan, for whatever numerous uses they may be required. If for the purpose of conveying numbers, as the present long, *double-bodied*, and extraordinary heavy Coaches, the *scale* being fixed by the breadth of the front, and fore axle-tree, for three persons to sit, the *driver* and *two* others (which is improper); or, *three*, within, on the first seat; a middle seat may be added holding *three*, or *four*, by the sides of the body being made convex; the door should open at the ends of this middle seat; which divided into three equal parts; each terminating division would form alternately a seat and step, as before described: the back seat, lengthened by the *swell* of the body, or *expansion* of the platform, will hold four, and thus accommodate *ten* inside passengers. Whilst, agreeable to the reasoning in the former case, five may sit with *their backs* to the Carriage, *outside*; and as many more, if so absurdly and improperly required, may be placed on a seat similar to the one contrived for the seat of the guard, by increasing

its length. And, if the boot and box previously described, be insufficient, then may be *appended* to, and *under* the hind axle-tree, if necessary, *sub-imperials*, for the accommodation of stowing luggage. The same observations equally apply in an inverse ratio, for constructing the more *reasonable* and *profitable* lighter Carriage for two horses, or for the draught of a single horse.

If the Author does not deceive himself by a too great confidence in *his* conception of the lever, he is not without a hope, that *others* will perceive its *effect*, in a considerable degree thus applied, whenever an obstacle shall *shock* and *impede* the front Wheels. In such cases, the load being adjusted as previously provided, if that *axiom* be not controverted, upon which this conclusion is founded, will not that *endeavour* of *gravity* to get behind the centre, acting upon the after extremity of the platform, the hind axle-tree answering as the *fulcrum*, correspondently *lighten* the pressure *before*; and assist the *lifting* power of the cattle at the end of the pole?

The foregoing remarks and directions are more immediately and particularly designed for artizans, in the constructing Carriages for the *conveyance of the Mails*, and all other Four-wheel Vehicles placed on springs, to assist them in comprehending the proportions of the several parts; yet, the *principles* will be regarded in the manufacturing or building of every *other* kind of Carriages, in whatever particular they may apply. The common road Waggon of any size, or for any purpose, may be thus constructed, as relates to the *Carriage-part*, by observing the rules here laid down; whilst the *base*, or *platform*, may be fastened down to the framing of the *front* and *hinder* axle-trees, in the usual way; upon which a body of any form may be raised as shall best answer the intended purpose: keeping always

in view, the principle of the *wedge*, the line of *inclination*, and the due *adjustment of the load*, as herein particularly described.

The method by which all such Carriages herein are to be propelled or drawn, is precisely the same as the one previously explained; except, that the *tractor* for the tongue, or Wheel horses, is to be formed, *at the same elevation from the plane* of the road, by an iron triangular-tractor, whose base is to be the *front* of such Waggon, and fastened to the sides of the same by means of strong hooks and eyes, or otherwise, *ad libitum*, so as to operate by such means; and the point or angle, to which the *swingle-bar* is attached in like manner, by a hook and eye, is to lie (when acted on) *precisely* over the *centre* of the junction, or embrace of the pole with the futchels: thus producing simply an *union of draught*, by means of triangles, projecting from the true, and proper *base*, the *load*, or burthen which is the subject of traction.

From these remarks and directions it appears all Four-wheel Carriages, so constructed, will *roll different surfaces*, and have different bearings on the road, according to the elevation of the Wheels; the higher ones, destined to bear the heavier portion, will have a correspondent increase of *pressure*, axle, &c. &c. as before stated. Reserving for future consideration, *general rules*, and *particular* directions relative to *Wheels* of a certain description, it may here be proper to observe, the *front* Wheels of no Carriages need be *dished*; but that with the view of providing an advantage *now* deemed *important* in common practice, the hind Wheels, where their *breadth* of pressure is insufficient for the purpose of *protecting the nave* from collision with the *rims* of others, such Wheels may be a *little dished*, so that the periphery of the Wheel and extremity of

the *nave*, may project equally, or otherwise, as may be found adviseable.

The *common road Waggon*s, already described, may be furnished with springs *under* the platforms if desired, in the usual mode of fixing springs; but, *another kind* of Waggon, and Carts; entirely different and novel are to be constructed in the following manner,—the Waggon, in the principles, and *form*, so far as respects the Carriage-part, will differ little from the former: for it is to have the axle-trees connected by a single perch in the middle, as in the usual method of construction. The body however is to rest, and traverse longitudinally upon segments of circles, whose semidiameter is *eleven feet*; which said segments are to be sustained by the means of springs of various lengths, bolted down to the frames of the several axle-trees in the usual way; or upon blocks, bolsters, or other contrivances, sufficiently elevated for locking the fore Wheel one-eighth round *without springs*: these segments may be of wood, faced with iron, or, of iron or other metal solely; the front portion of these segments to be contracted about *one-third*, so as to correspond with the front and *shorter* axle-tree; the remaining *two-thirds* must be expanded so as to fall precisely within, or upon the line of the wedge-form platform, recommended in the former instances; both *portions* of which are to be parallel to each other, opposite and corresponding segments; which segments are to be divided into *three equal* parts; and, upon each, three friction rollers; or, if found more eligible in practice, instead of *rollers*, iron circular *keels*, like *skate-irons*, may be adopted: in either, or both cases, *they* will traverse upon the *segments* or *circular base*; checked by means of the two ends of the same before and behind; and two intermediate *stops*; thus admitting the body to slide backwards

and forwards, as the Waggon is going down, or up hill, and preserving the floor of the same in all cases *level*. Respecting the length of the segments, or circular base, it will be peculiarly necessary to observe that the front end should be not projected beyond the periphery or rim of the front Wheel when the Waggon is standing on a plane, and, of course, the body level.

The diameter of the said front Wheel is to be nearly the length of the first division, or third part of the *segment*, whilst the hind Wheel, or rather its *nave*, will be under the centre of the other two-thirds of the aforesaid segments, and body. Upon the top of these segments, about six inches deep, will be a circular bar of *union*, corresponding with the base, and attached to the *stops* previously alluded to, and each extremity. The body, *conformable in shape* to these segments, is to be furnished underneath with *iron plates* fixed longitudinally, so to correspond with the base, and axles for the friction rollers, or *skate-irons*, upon which it moves, and varies its position in ascending and descending hills, always preserving a *level*, if the ascent or descent does not exceed fifteen degrees. The most adviseable length for the level floor of the *body*, or the *chord* of the *arch*, will be ten or eleven feet, upon which the same may be raised and expanded laterally, and at the extremities, in the usual way. The diameter of the front Wheels, the standard of proportion in other instances, must be the regulating principle here. The lower, however, *these* are, the farther apart must consequently be the axle-trees, to raise the floor sufficiently high for the draft of the Wheel horses, and to keep the load *above water*.

The mode of drawing in these Waggon, as it respects the Wheel cattle, *differs* from the others, that, instead of a single *tractor*, united by *hooks* and *eyes*, the form is to be nearly reversed; but, it tra-

verses up and down by oval *holes* at the end, upon *segments* of circular irons, formed upon the *eleven feet* diameter also, the chord of which reaches from the lowest point of the body, in front, to the distance of twelve to eighteen inches *above* the centre of the cattle, (say four feet) the inner part of which is round or cylindrical: it *may*, however, be made flat, and the *hole* of a different form, furnished with a friction roller, stayed by a spring; whilst the outer edge is jagged somewhat like a whip-saw, in order that, by means of the same *tractor*, which is also extended at the same time, like a *light pair of shafts*, it may be *backed* upon, and the progress of the Carriage, down hills, be retarded. For by this contrivance, the point of *traction* slips up and finds its proper level, as the cattle *ascend*, and the load consequently *descends* upon the base, till stopped at its extremity. *Upon a level*, the point of *traction* is precisely at the end of the *line of gravity*, or at *bottom* of the load. These principles and contrivances being understood, the use of the *tractor* will be apparent, operating upon the *front* or *jagged face* of the segment, which it embraces, in *backing* down hills, producing the desired effect, that of preserving the load level.

In fixing these *tractors*, the centre of the front part of the body must first be found, and then sufficient space allowed from *that*, to the centre of each horse on either side; thus the proper point will be ascertained, from whence to *draw*, and by which to *back* and traverse. The shafts must be rendered as light as possible, and adjusted to the size of the animals which are to draw simply by collars, hames, and *tugs*, or broad breast-plates. A *fixed* breeching also may be contrived, for there will be no occasion for complicated harness, the shafts ever yielding to the action of the cattle, whether undulatory, zigzag, or otherwise. It however will be

requisite, by all means, to prevent *diverging* efforts; for this, like many other things too much neglected, is highly advantageous, may be effected by *coupling* reins, and attention on the part of the driver.

In the form and construction of Trams, or iron rail-way Waggon, as these, from the circumstance of their *parallel tracks*, cannot be in the *wedge-form*, a difference may be admitted. And it is singularly curious, that analogy in nature is here observable. The elephant and the ox, by nature designed for slow motion, and heavy burthens, have their legs and feet placed different from those of the fleetier animals; and in their foot-steps, if inclosed by *four right lines*, each touching *two footsteps*, little, if any, of the *wedge-form* will be perceived in the figure. *These* Trams, therefore, may be constructed upon axle-trees of *equal* length; and, as there can be no *indentation*, the periphery of the Wheels, or rims, may be nearly equal. In all other respects, the principles which have been previously explained will equally apply.

The front Wheels of the rail-way Waggon, or Tram, must be six inches diameter, the hind ones elevated according to what may be deemed a proper *length* for the *body*, so as to preserve the *three degrees* of *inclination*, observing that the front part of the platform projects beyond the axle-tree *no further* than *even* with the rim of the fore Wheel; and, that in like manner, the *hinder part* be even with the *rim* of the hind Wheel. The *first* being built will furnish the *ratio* for the whole *series* intended to be *constructed*, and calculated for any given *power*, the space between the first and second, and every succeeding Tram must be *fixed*: but this must depend on the *turnings* in the road; because of the necessary *play*, or liberty to be allowed: fixed, however, it *must be*, when every *successive* Waggon is formed by the rule prescribed for the

first, elevating the *successive* Wheels, *increasing* the *diameter* of the axles, "as in all cases of Wheels," and consequently the length of the bodies or platforms, and in the height of the bodies, and other respects, the mechanic may apply his skill to render them sufficiently and *proportionately* strong, and, at the same time, as *light* as possible. The *length* of axle-trees must also depend on the width of the road. The method of drawing is precisely the same as directed for the Common Road Waggon, except that, instead of a *swingle-bar*, and *swingle-trees*, *one* only is necessarily attached to the end of the tractor, affixed to an elevated point; and on each *side* of the body equal to the centre of the horse, or to the more appropriate mule. And if the *expence* did not preclude the idea of realizing such a scheme, a still greater *improvement* might be suggested: which would be, to *dig out a track* in the middle of the road, or to *raise the tracks* for the Tram Wheels, and so sink the step of the mule or horse, till his *centre* fell to a line with that of the whole *series* of axle-trees, to which the *tractor* might be affixed: by which plan there cannot be a doubt but great and *increased effects* would be produced.

In the building of *Carts*, little need be added to the directions already given for *Waggons*. The *principle* is the same as elucidated in the drawing; and it will require little skill to adapt the *shafts*, both for supporting, as in cases for *the Gigs*, the Wheels, axle-tree, and frame; and also those *inner* and smaller ones, by which to *draw*, and *back*, alternately, according to circumstances.

GIGS AND CURRICLES.

THESE are to be hung upon similar springs, as will be clearly understood by the drawings; or, the springs may be under the shafts, or *frame*, as is at present done with single or double grasshopper-springs; in which case, the *springs* represented will serve to show the *form* of *stays*; and the *stays underneath*, of course, will be then replaced by other springs. But, the *principle* here claimed, is found in the *crank*, upon which the improvement depends.

Whatever latitude may be construed as granted to others in the stile, form, and external appearance of the bodies of pleasure Carriages, a *particular* one is reserved, as per imperfect drawing, together with all and every improvement that the symbol is susceptible of; *this* being an *acorn*, with leaves, branches, and the tree itself, of which it is the fruit; the *allusion* in all its possible lights, decorations, and representations, being particularly and expressly excepted, and reserved.

WHEELS AND AXLE-TREES.

THE diameter of *all Wheels* must regulate that of *their axles*; *one-eighth part* of the *former*, gives a *proper* proportion for the *latter*: the *length* of the arm, or bearing of the axle within the box; and the *length* of nave, *in the clear*, to be equal to *such diameter*! The *breadth* of the rim of the Wheels, or width of pressure on the road, precisely the same with *these*. In Carriages designed to carry loads exceeding *three tons*, *these proportions* may be *increased*, even, to *one-fourth*. And, for lighter Carriages intended for pleasure, and others calculated for great velocity, the *bearing* in the boxes of the *first* class, may be diminished alike at each end of the nave, even to *one-half* the *ratio* here given; as also the tread or track thereof: because “velocity diminishes gravity,” and consequently the *intensity* of *friction*! And if more enlightened minds, to whom these remarks are most respectfully submitted, should require a *remedy* for the *lateral pressure* occasioned by declivous roads, which causes the Carriage to *lean over* on one side, so as to excite alarm; it is at hand: nothing being required, than that such declivity in the road, or hill side shall be reduced as far as possible to *less than fifteen degrees* of *inclination*. In all things relative to these important parts of a Carriage, the *true cylinder* is to be observed. The *dishing* of Wheels, as before specified, may be supported from a *fact*, and the consideration, that *horses* that are *little cat-hammed*; or,

whose *hocks* bend inward; or, *knock-kneed*, are most *active*, and are firmer on their feet, than animals having straighter limbs.

The theory and comparative advantages of Wheels according to their relative height, so satisfactorily demonstrated by MR. CUMMING, in his report laid before Parliament, serves to justify a preference of the *smaller*; and will doubtless render the one here *specified*, worthy of consideration. It consists of eleven wooden spokes, and as many sections of circles of *cast iron*; and an equal number of wood, or iron only: the joints, or union of these, are *broken* in like manner as those of *brick-work*. The section point of the wooden ones meeting in the centre of the others; fitted into *sockets*, in the bottom of which, are *thin wedges* left in the casting, receiving the *foot* of the spoke which is inserted in the *form* of a lozenge, between the meetings or *nicely jointed wooden segments*.

Those of *cast iron*, meet in the middle of the others; in the centre of each end is left also in the casting, a *nicely formed semi-lozenge-shaped* space for the passing of a *correspondently formed wedge-bolt*, accurately made of *wrought iron*, a *very small portion larger* than the *two semi-lozenge-shaped* spaces, in order that by means of a nut and screw at the end, passing through the wood also, and nicely fitted, the *nut* and the head of the bolt may be *forced home*, or *very nearly* so; leaving it to *time* to *adjust* all those inequalities, which are inseparable from *any combination* of *several* parts in machinery; and thus render the connexion of the *whole*, more compact and firm.

The structure and proportions of the *nave* and axle-tree, it is hoped will be comprehended by an inspection of the drawings, and the use of their *common* scale, in addition to the preceding description. The *sockets* of this, as well as those of the

rim, are furnished with *wedges* to receive the *heads*, or upper end of the spokes, which are in like manner accurately fitted: observing, that *these sockets* laterally embrace the spoke higher up, as will be evident from the section of the nave and axle, thereby additionally contributing to confine and corroborate the whole *complicated* machine, *simply* by the *application* of the *powers* termed the lever and the wedge.

The diameter of this is appropriated for the fore Wheel of a *light Coach*; whilst, from an ignorance of the *proportionate quantum* of the *necessary materials*; and a still more awkwardness in the art of drawing, these are evidently large enough to be *reduced* either for a fore Wheel aforesaid, or even for those of a *Cart*, capable of bearing seven tons; in which latter case the diameter of the axle will be enlarged to one-sixth or one-fourth, instead of one-eighth.

ROAD SCRAPER AND EARTH PORTER.

AMONG other designs for a practical application of the powers of the lever and wedge, a rude drawing with the *legal specification*, will explain a machine with four Wheels, denominated a "Road Scraper and Earth Porter," contemplated to be drawn by a yoke of *oxen* in preference to other cattle; and two persons only: the simplicity of which contrivance, it is to be hoped will induce those whose peculiar purposes it may serve, to give it a fair trial. It is calculated, as from casual observation it was *conceived*, to *scrape* or *shovel* up any accumulations of semifluid or loose matter necessary to be removed, more especially from flat and level roads, such as from Knights-bridge to Turnham-green; or, in the *formation* of roads, or other like purposes *after* the plough, or other mode of *loosening* the earth to be removed.

The shovel is commanded by one person holding a *lever* behind, similarly disposed as the one to the harrow; whilst another lever serving the double purpose of a pole or tongue to which the cattle are attached, conducted by *another person*, is alternately made to act in concert with *those* behind, elevating the shovel aforesaid, when by *progressing* its *wedge principle*, it becomes loaded. In this situation it is preserved by a bar or handspike rested on the *pole* aforesaid, with the side chains simply thrown over its ends. And, when drawn aside to a given deposit, it is *discharged* with great facility.

It remains to be seen, whether *this mode* will not effect greater advantages, than twenty-five men, as were observed employed early in December 1809, upon the road aforesaid, for the same purpose. This design, moreover, may be extended to *Carriages for field artillery*, as may be more perfectly comprehended by an inspection of the specification and drawing aforesaid.

COMBINATION TRACTOR.

THIS is more particularly requisite for Carriages drawn by a single pair of horses; it is to be formed of iron rods neatly wrought, projecting upwards from each end of the bolster, where it must be loosely jointed, and elevated so as to meet at two feet distance, more or less, from the bed-pin, the bar or rod to be nine inches in length suspended from, and in like manner loosely jointed under the foot-board, upon the line of seats; thus forming a *firm and stiff* angle, from which by means of an eye the team are to draw by swingle-trees. The two *lower* parts of this triangle contrivance may have intermediate joints, so as to play in concert with those before described freely, according to the flexion of the springs, and undulatory motion of the horses, thus combining the lift and draft, answer all the grand desiderata in the long-agitated, and truly important questions respecting *levation* and *traction*.

FINIS.

